

The seismicity of Iran.
The Silakhor (Luristan) earthquake of 23rd January, 1909
(Part II)

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SUMMARY. — This paper shows that given certain conditions it is perfectly feasible to study an earthquake that occurred three-quarters of a century ago in a remote part of the world. Also, it shows that there are many large earthquakes which, because of lack of interdisciplinary efforts to study such events, have remained hitherto little known or totally unknown. The case of the Silakhor earthquake revealed deficiencies in the determination of epicentres by ISS and Gutenberg; the difference between macroseismic and instrumental position for the Silakhor earthquake is 380 kilometres, a difference which has caused a serious problem in the assessment of seismicity of Iran. Accurate macroseismic data may be used to minimize bias in the instrumental relocation of the larger events and to study source mechanisms. Until this study was undertaken, the faulting associated with the Silakhor earthquake was totally unknown. Even more important than the value of recent faulting for its significance in resolving ambiguities in the choice of the true source parameters, is the information that can be gleaned from evidence for the mechanism of earthquakes that occurred long before the advent of modern seismology and in particular, for the pattern of recent tectonic activity.

RIASSUNTO. — Questa nota dimostra come, date determinate condizioni, sia possibile studiare perfettamente un terremoto avvenuto 75 anni or sono in una remota parte del mondo, mentre di molti grandi eventi si conosce poco o niente proprio per mancanza di sforzi comuni per studiarli. La determinazione di epicentri nel terremoto di Silakhor (da parte dell'ISS e di Gutenberg) ha rivelato alcune inesattezze: la differenza fra l'epicentro

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macro-sismico e quello strumentale è di 380 km, una differenza che ha procurato un problema serio nella distribuzione della sismicità dell'Iran. Dati macro-sismici accurati permettono di ridurre al minimo le differenze nella ricollocazione degli eventi (con i dati strumentali) e di studiarne il meccanismo focale. Finché questo studio non è stato intrapreso, la faglia associata al terremoto di Silakhor è stata totalmente sconosciuta. Più che per il contributo dato nel risolvere ambiguità nella scelta dei parametri relativi alla vera sorgente, la recente faglia è importante per le informazioni che essa fornisce nello studio del meccanismo di terremoti che sono avvenuti molto tempo prima dell'avvento della moderna sismologia e, in particolare, per il modello della recente attività tettonica.

INTRODUCTION

During the writing of the paper on the Silakhor earthquake of 1909 ⁽⁴¹⁾, an important unpublished document came to our attention ⁽⁵⁸⁾, unfortunately too late to be fully incorporated into the paper.

This find, apart from its significance for the information it contains, raised the question of how much additional information about this particular event, or for that matter about other historical earthquakes is likely to have survived in various offices of public records and archives and of how such information could be retrieved. While writing the Silakhor paper, the most readily accessible state documents of the period were searched (*), but these were found to contain little more than summaries of consular reports from Persia, dealing chiefly with political events and trade statistics.

Taking the Silakhor earthquake of 1909, therefore, as a test-case of an event that happened 65 years ago in a remote part of Persia, we attempted a search in various archives in this country as well as in Iran and in other countries which at the time of the earthquake maintained consulates and trade missions in Persia. We looked for published and unpublished information that could throw more light on the effects of this important event. Much of the present paper, therefore, is derived from new evidence which was found during this search as well as from additional work carried out in the Silakhor area that completes our knowledge about this event. In a sense this paper is a continuation of that published earlier (**), and it is written with the dual object of

(*) *Command Papers* (1909; 4581/78) (1910; 4962); *State Papers* (1909; 4559) (1910; 4365).

(**) Figures and references in this paper are numbered in continuation of those in (41).

answering a number of questions raised earlier about this earthquake in the Zagros mountains ⁽⁴¹⁾, and in particular of showing that under certain conditions it is perfectly possible to document historical earthquakes and to retrieve useful information that may help explain the long-term seismicity and tectonics of areas which until recently appeared to be seismically quiescent.

NEW EVIDENCE OF THE EFFECTS OF THE 1909 SILAKHOR EARTHQUAKE

It can now be established that the first news about the Silakhor earthquake reached Kermanshah by post from Burujird two weeks after the event, on the 5th February 1909, and that it was on his own initiative and not at the instigation of Prince Galitzin that the Russian consul in Kermanshah, N. Nikolski, decided to send a field party in search of the epicentral area. In his report the consul says:

“In view of the considerable scientific importance of the data, no matter how approximate, that could be obtained about this earthquake which occurred in such a remote country devoid of any Europeans, and also because of the rumours of the great devastation that it caused among the local people. I, not being able personally to leave my post in Kermanshah, particularly not having a secretary to replace me, had the day following the receipt of the post from Burujird, 25th of January (old style) immediately ordered the newly appointed agent of the consulate Asad Allah Mirza to proceed to Burujird” ⁽⁵¹⁾.

The mission, which carried a letter addressed to the Governor of Luristan, Amir Afkhan, arrived in Burujird on the 10th February, via Bisitun – Sahneh – Kangavar – Farsfi – Avar Zaman and Ushuturinan, questioning people along the route. After spending almost five days in Burujird the mission marched to the earthquake region, which it entered on the 15th February. They spent in all ten days only surveying the damage in the Silakhor valley before they were ordered back to Kermanshah, allegedly because of the threat of an epidemic. Nikolski, in his report says that:

“fearing that the Agent and the cossacks sent by me might fall ill in the infected countryside, I have ordered them to return to Kermanshah; because of this they were able to visit only

part of the region struck by the earthquake, having gone as far as the village of Bahrain (Dorud) (53).

It is questionable, however, with the mission in the field only for ten days, that the news of an impending epidemic reached Kermanshah so quickly that the consul's recall orders had time to arrive in Silakhor. Nikolski, in his report says nothing of the imminent rising of the Kalkur Kurds around Kermanshah and the activities of the Qaed Rahmat tribes which, soon after the earthquake, occupied a number of ruined villages and busied themselves carrying away the buried stores of grain and home property, activities that might have hastened the return of the mission (*). That the threat of the epidemic was not wholly responsible for the premature return of the mission to Kermanshah is supported by Nikolski's own statement when, in another report he says:

"To confirm the truth (that the area of devastation extended to the southeast of Bahrain) by sending my Agent beyond the boundaries of the district for which I am responsible, seemed to be outside my original aim" (51).

The mission was back in Kermanshah on the 1st March, marching back via Burujird - Ushuturinan - Nehavend - Kangavar - Sahneh - Bisitun.

News about the earthquake reached Tehran three weeks after the event. On February 18th, Sir G. Barclay sent a telegram from Tehran to Capt. Haworth at Kermanshah asking for details of the Luristan earthquake (**). Haworth's consular diary for the week ending 2 February, had given nothing of importance for Kermanshah. On 21st February, Haworth sent a telegram from Hamadan to Tehran:

"Slight earthquake shocks Kermanshah and Hamadan early morning January 23 sharper Sultanabad. Stated some villages suffered between Sultanabad and Burujird details very indefinite. Sultanabad should have information".

A further telegram followed from Haworth at Malayer on the 4th March:

(*) 1. O/Confidential Diary Ahvaz/Corr. Files no. 70/713 March 1909.
 (***) F.O. 248/968

“Monsieur (undecipherable) late of the Post Office at Resht informs me that 47 villages were destroyed by the earthquake, that he saw a mountain which had been split in two, 35 miles from Burujird causing landslip which buried two villages and leaving gap 500 yards wide. Loss of life computed at 6,000. Damage commences 18 miles from Burujird. Shall I go to Burujird which is 21 miles away from here and get correct details?”.

It does not appear that he was instructed to do so, and the subsequent situation in Kermanshah was sufficiently serious to fully preoccupy the Consul's time. Although this is therefore all that he seems to have done on the matter of the earthquake, such information was clearly of interest to Tehran. In the Kermanshah Consular Diary for the period ending 20th February, the earthquake was mentioned much as described in the cable of 21st February with the additional information that the shock occurred at about 6.0. a.m. On receiving the Diary, Sir G. Bareley wrote thereon; “Summary; you will mention the earthquake of which there were some further particulars from an outsider in a telegram from Haworth” (*).

The news of the Silakhor earthquake reached Bushire and Ahwaz some time in the middle of March and they are recorded in the diaries of the British Consuls in these two towns (**). About the same time, a detailed account of the results of the earthquake in the Burujird district was received by the British Consul in Ahwaz (***), who paraphrased the original Persian Text of this account and included it in his diary. It is unlikely that this detailed account was derived from Nikolski's report, not only because these two documents cover completely different aspects of the earthquake, but also because it was not until a month later, on the 18th April, that the British Consulate in Ahwaz became aware of the Russian activities in the Silakhor valley for which the British Consul shows in his diary evident signs of distrust:

“It is reported” he says “on good authority that about two months ago two Russians dressed as cossacks came to Burujird. Shortly afterwards a wire was received in Burujird from the

(*) F. O. 248/968

(**) I.O./L/P & S/7/227 no. 11/595; no. 13/647; I.O./I.C.E. no. 71/850; 72/1017

(***) I. O/Confidential Diary Ahwaz/Corr. Files no. 70/713 March 1909

Sadr Azam, saying that another Russian accompanied by his interpreter was coming to investigate the damage done by the earthquake. On arrival of the latter, who is said to be the Russian Consul's Deputy from Kermanshah, a house was taken on one year's lease. The interpreter is said to be a man of good birth from Kermanshah. After making exhaustive enquiries as to the roads, stages, etcetera in the district, the latter arrival and his interpreter started towards the Isfahan road via Silakhor and Chahar Lang Bakhtiari, with the ostensible object of visiting the places devastated by the earthquake. They were escorted by a party under the Mansur al Mamalik, who had been appointed by the Amir Afkhan". (*)

A month later the Ahwaz diary of the 18th May, under the title "Russian Activity in Luristan" adds that

"nothing further has been heard of the Russian and his interpreter who were travelling ostensibly examining the places devastated by the earthquake". (*)

The destruction caused by the earthquake in the lower part of the Silakhor Valley was indeed very great and it is vividly described by members of the Russian mission. They found that in many villages.

"virtually nothing remained above ground. We could find there not a single survivor, of whom one could enquire details about the disaster; only packs of dogs and ravens tearing at the corpses disturbed the silence of the ruins. Only in a few villages some inhabitants could be found, living in huts which escaped destruction; the majority of the Lurs and Bakhtiari's fled even as far as in the districts of Isfahan, trying to find a possible abode in the villages untouched by the earthquake. . . . What is even worse, nearly all domestic animals have perished and now, despite the early sowing season and plentiful spring rains, nobody can undertake any field work without draught animals" (55).

The disaster gave rise to curious tales, not all of them completely devoid of some truth, and to exaggerated accounts of the effects of the earthquake. Persian reports indicated that.

(*) I. O./Confidential Diary Ahwaz no. 850-1017

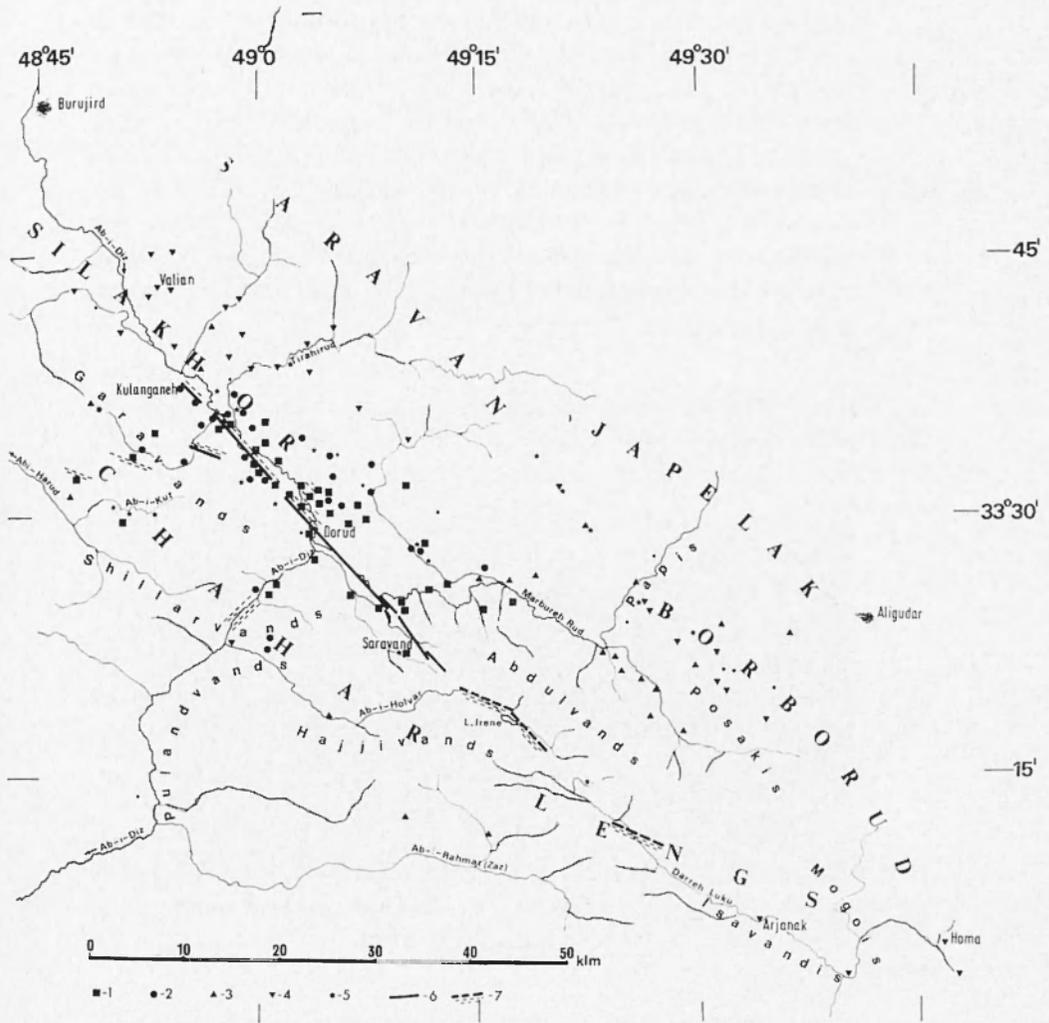


Fig. 1 - Distribution of damage caused by the Silakhor earthquake of the 23rd January 1909. 1: Location of villages totally destroyed with more than 50% of their inhabitants killed; 2: villages totally destroyed with less than 50% casualties; 3: villages heavily damaged or destroyed without casualties; 4: localities and villages that suffered some damage; 5: modern settlements; 6: abandoned sites; 7: fault-break associated with earthquake; 8: regions of extensive ground deformations, landslides and rockfalls.

“over 40 villages, from Chalan Chulan eastwards are said to have been destroyed; in most cases only two or three men or a single fowl are left alive. Villages are said to have ‘gone down’ and totally ‘disappeared’, and tales are told of a river which flows into a chasm, and of an old fort with walls 30 feet thick which has been precipitated bodily from its place for a distance of a ‘maidan-i-asp’ (say 600 yards) and been deposited in the bed of a river” (*) . . . “In the district of Mavar-Zarrin (**) hundreds of families and all their animals belonging to Hajjivandis were overwhelmed by the fall of a mountain which buried them” (58).

Consul Nikolski describes the dreadful sanitary conditions in Silakhor and stresses the danger of infectious diseases originating there among the survivors, and then spreading over the whole of Persia. He says:

“The suffering of the people is further aggravated by the dreadful sanitary conditions in the countryside destroyed by the earthquake. The corpses of people and animals, in places hardly covered by the ruins, in places dug out by the pack of dogs, decay in the warm rain and under the hot rays of the spring sun and infect the surrounding atmosphere over many versts” (51 53).

He recommends that the Government should undertake immediately full measures required to make these areas fit for habitation again and to prevent the spreading of infectious diseases which might originate there. In his letter to the Charge d’Affaires in Tehran, E. V. Sablin, he says:

“The destroyed villages remain in the same dreadful state in which the earthquake left them. Nobody is attending to the dead, and nobody extends a helping hand to the living, who face death either from diseases or from starvation” (51).

(*) I.O./I.C.R./L/P & S/7/228 no. 713 Confidential Diary 70; cf. F. O. 248/968

(**) Presumably the mountainous region beyond Zarrin, between Derrch Luku and Ab-i-Holvar.

He suggests to Sablin that the Mission in Tehran should organise a collection of money among Europeans in the capital and that Russian consuls in Persia should also contribute. He goes on to say that:

“As there is no hope whatsoever that the Persian Government or people are able to offer any assistance to the victims, . . . I am prepared to shoulder the distribution of these funds among those in real need. Perhaps, the Credit Bank of Persia will be willing to take part in this mission of mercy and agree to transfer to me free of charge these donations through Mr. Agam, their correspondent in Kermanshah” (51).

Nikolski also made an appeal to the Ministry of Foreign Affairs in St. Petersbourg suggesting the formation of a Central Committee for



Plates 3 - The village of Sangar photographed by Sukhenko in February 1909; looking west.

assistance to the victims of the Silakhor earthquake which he suggests could be organised along the same lines as the St. Petersbourg-Mesina Fund which was established a few months earlier after the Mesina earthquake in Italy of the 28th December 1908 (53).

To what extent Nikolski's appeal materialised we have been unable to find. We know that E. V. Sablin, the Russian Charge d'Affairs in Tehran, offered himself to chair a relief committee, but there is no evidence that such a committee was ever formed (58). There is evidence however, that in April 1909 a fund for the victims of the Silakhor earth-

quake was opened in British Consulates. The Sistan Consular diary for the 12th June shows that:

“A Luristan earthquake fund was opened in Birjand some two months ago. The Hashmat al Mulk, Shaukat al Mulk and a few others, including Mr. Howson, assisted in the collection of funds. Mr. Howson acted as treasurer and kept the accounts; and a sum of 6,299 Krans has now been remitted to Tehran” (*).

However, the Luristan Earthquake Fund was ill-fated; in the Sistan Consular diary of a few days later, we read that

“His Britannic Majesty’s Minister has wired that no (Luristan) Fund exists in Tehran . . . and that the subscribers wish to have their money back” (**).

As a matter of fact on June 2nd, Sir G. Bareley sent the following telegram to Kermanshah (***):

“Do you know anything about Luristan Earthquake Fund?

I have received nearly £100 from Sistan, for this purpose”. He does not seem to have been answered on this matter. It does at least seem, however, that there was a certain amount of interest in this earthquake, once news of it reached Tehran, apparently in the second week of February. From the sequence of correspondence, it looks as though the earthquake would have gone almost unnoticed and would almost certainly not have been recorded by the British representatives in the area, had not the Tehran Embassy pressed for news.

So, with the exception of two short poems composed by natives of Burujird and Kermanshah which lament the victims of the Silakhor earthquake (42), we could find no other evidence of concern about the situation created by the earthquake in this remote part of Persia (****).

(*) I.O./L/P & S/7/230 nos. 22/1048 & 23/1113.

(**) I.O./L/P & S/7/230 nos. 22/1048 & 23/1113.

(***) F.O. 248/968

(****) One of the reports is accompanied by six photographs, two of which Plates 3 and 4 are reproduced here (51). Another report is accompanied by four plates (in glass) showing the damage in four villages, too faint now, damaged by time to give good prints (58).

One of the important question that remained unanswered in our earlier paper ⁽⁴¹⁾ was that of the actual extent of the meizoseismal area of the 1909 earthquake, particularly to the south of Bahrain. From Shtelling's report ⁽³³⁾ it was evident that owing to the premature recall of the Russian mission to Kermanshah, information about damage in the region south of Bahrain (modern Dorud) was incomplete. This is confirmed by Nikolski, who, however, makes it quite clear that damage did extend beyond Bahrain. He says that:

“from my Agent's words, based on information he received, the earthquake of the 10th of January (old style), while moving in the direction of Isfahan, has destroyed many villages among the Bakhtiari Haft-Lengs. The area of destruction apparently extends to Isfahan itself, the number of destroyed villages being up to 128 along the track from Burujird” ^(39, 52).

He then goes on to describe the damage to 27 villages visited by his mission in the Silakhor Valley to the north of Bahrain ⁽⁵¹⁾. In his report, however, Asad Allah Mirza adds the description of damage to another 31 villages belonging not only to the Silakhor Valley but also to Razan in the northwest and to Japelak and Borborud to the southeast of Silakhor, mainly inhabited by Bakhtiaris of the Chahar Lang



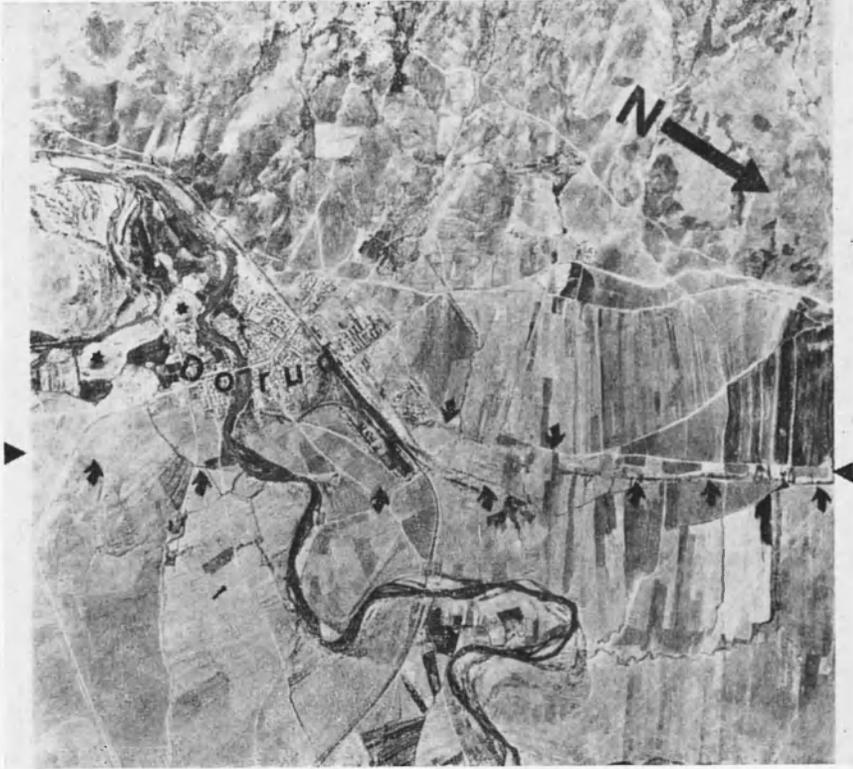
Plates 4 - The ruins of Sandargan as seen by Sukhenko shortly after the earthquake; note ground deformations in the foreground, viewed from the north.

tribe⁽⁴³⁾. This report confirms that damage extended well outside the Silakhor Valley, a fact which is attested by another valuable source of information⁽⁵⁸⁾ which gives a detailed description of the losses sustained by various tribes and sub-tribes of the Chahar and Haft Lang Bakhtiaris as far south as Homa and Arjanak. This document seems to have been prepared as an appendix to a Persian intelligence report dealing with local revenues and taxes and on the general tribal situation in the area after the 1909 earthquake.

Table 1 gives a summary of all the information available regarding the effects of the Silakhor earthquake of 1909. This table includes information from published and unpublished sources as well as data collected from local people during the author's field trips in the region 64 years after the earthquake. Figure 5 shows the distribution of damage as well as the approximate location of tribal groups in 1909.

As already noticed⁽⁴¹⁾, damage was most serious in the densely populated Silakhor Valley where many Lurs and Bakhtiari Haft- and particularly Chahar Langs, perished. The Chahar Langs belong to a division of the Bakhtiaris, a tribe of nomads the majority of whom migrate annually between their summer and winter quarters, and whom in 1909 should have been confined mainly to the mountains and high valleys between Silakhor and Isfahan⁽⁴⁸⁾. However, well before 1900, a good part of the Chahar Langs had already become sedentary, dwelling in small villages scattered in the mountain valleys and plains, chiefly to the west and southeast of Silakhor^(44,46). The other main division of the Bakhtiaris, the Haft Langs, partly settlers and partly nomads, occupied the region located roughly to the southwest of the Chahar Langs with ill-defined and fluent borders between the two tribes, Figure 5.

The 1909 earthquake caught most of the Chahar Langs in their winter camping grounds and villages, killing a large number of them; landslides and rockfalls added to the destruction, particularly of their animals. If we trust a contemporary account of the disaster, the sub-tribe of the Hajjivands was decimated, losing 300 families and all its animals. Half of the Abdulvands who lived on the flanks of Shaturun-Kuh were killed or perished in the cold in their winter quarters; survivors were forced to abandon the mountain pastures which after the earthquake were said to have become dry "and strewn with grey ash". The Posaki tribe lost about 100 families "who were buried under the mountains that fell on their winter villages"; survivors were obliged to abandon temporarily their pastures and hamlets on the southeast



Plates 5 – Aerial view of the fault-break associated with the 1909 earthquake at Dorud.

slopes of Shuturun-Kuh and seek refuge further south among the Mogois. The latter suffered few casualties but some of their fortified villages were ruined as far south as Homa. In this region rockfalls killed a small number of Isavandis and caused the mountain track to the north through Mavar-Zarrin to be closed; at the latter locality hundreds of Hajjivandi families and their animals perished. To the northwest of Silakhor, in the Razan-Rangrazan (*) area, about 100 families belonging to the Garavand and Sagvand(?) tribes perished together with all their animals and stores of grain. After the earth-

(*) In (41) the region of Rangrazan is wrongly identified as that near Razan on the Abe-i-Diz. In fact Rangrazan occupies the northwestern part of the Ab-i-Kut valley southwest of Razan.

quake the tribe of the Pularvands of the Khanabad region, although they do not seem to have suffered any great loss, abandoned some of their tribal territory and moved across the Ab-i-Diz to the southwest causing considerable unrest in the region along the Khorramabad route (58).

Although it is difficult, almost impossible to establish today the exact boundaries of these tribal areas as they were in 1909, it is obvious that the earthquake played havoc among those tribes who lived on either side of the Shuturum-kuh for a distance of at least 40 kilometres to the southeast of Bahrain. The contemporary accounts already mentioned testify to the destruction of about 1000 households, including those of tribes in the Silakhor Valley, notably of the Bairanivandis. Assuming that the average number of people was eight to a household (44) the total number of casualties should have exceeded 8,000 (*), a figure most probably grossly exaggerated by the author of these accounts from which Sablin (58) drew this information (**). However, in the Silakhor Valley alone, 1,703 people were reported killed "excluding women and children and the inhabitants of villages and settlements without survivors, whose number could not have been estimated even approximately" (51).

Some of the earthquake effects mentioned in these reports are interesting as they allude to faulting:

"In many places (past Zargarán) one could see land-slides and cracks in the ground: in depth these cracks did not exceed 3 arsin (***), their width varied between several versok (***) and 4 arsin; the length of some cracks extended to several versts (***). The appearance of the rocks found on the vertical faces of the cracks tends to suggest that some hot water and steam came from underneath polishing them" (51).

"Khosranabad, a large village belonging to Hajj Aqa disintegrated; the ground opened up in many places tearing houses apart, swallowing walls and water coming out of the ground flooded the ruins... Choqa Abdar, the property of 'Ali Khan was divided in two for him by the earthquake; one part for his

(*) Bell (1889) reckons each Bakhtiari family at five members; Bishop (1891) at eight.

(**) In 1884 the Chahar Langs numbered about 12000 families and the Haft Langs 11000 in all (45).

(***) 3 arsin = 84"; vershok = 1 3/4"; verst = 3500'.

elder son Mirza Massud and another for Hussain Aqa(?) . . . Cheshmeh-ab was turned upside down when the earth split in two from east to west" (58). "A river now flows into a chasm".

A photograph taken by the Russian mission near the northern edge of the village of Sandargan testifies to considerable ground deformations, Plate 4. Much of this information about faulting has been already substantiated (41); faulting did extend from near Kalanganeh to south of Saravand, a distance of over 40 kilometres. To the southeast of Saravand there is no explicit evidence of faulting associated with the 1909 earthquake. There is, however, a tradition suggesting that apart from Lake Irene (*) there were two more, smaller lakes created by the 1909 earthquake and that their water having found an exit in the chasms in the ground caused by the earthquake, gradually disappeared. This is very reminiscent of the local tradition related to Morgan by Silakhoris in June 1891, i.e. that very long ago the two valleys of Silakhor were a lake and that the Prophet having cut with his sword the mountains, the Tang-i-Bahrain was formed and the waters flowed from there towards Dizful on the Ab-i-Diz(ful) (49). As a matter of fact, the Prophets' sword, the major geological fault that runs through this Tang and its 1909 dislocation all allude to earlier earthquake events in this part of the Zagros.

There are some allusions to the past earthquakes and large scale landslides in the valleys to the north and south of Lake Irene and in

(*) Part of the area affected by the 1909 earthquake was visited before and after that year by a few European travellers, i.e. Layerd in 1840 (46), Loftus in 1856 (47), Bell in 1884 (45), Sawyer & Bishop in 1890 (57, 44), Morgan in 1891 (49, 50), Strauss in 1903 (59) and Wilson in 1911 (36). They went over the same ground, but the names of villages and mountains differ much, depending with whom they travelled, i.e. Luris, Bakhtiaris, Persians from the north or local guides who gave them the names in use among themselves.

Lake Irene was first described by Sawyer (56, 57): "To the northwest" he says "at the inner foot of the Shuturun-kuh, is another lake as yet unknown to the world at large. . . This lake is said to have been seen by a European a few years ago, an employee of Hotz & Son. Really nameless, even locally. . . it might suitably be known henceforth geographically as lake Irene. . . after my little daughter". Shortly after Sawyer, the lake was visited and photographed by Morgan (49,50) who calls it Lake Gahar or Ghahar. Strauss (59) calls the lake Ab-i-Keher, while we found that local people call it Ab-i-Mianeheh or Miunah.

the Darreh Luku even beyond Arjanak. Before the 1909 earthquake, Sawyer, travelling in 1890 between Lake Irene and Saravand remarks:

“The whole of the valley to the south of the Shuturun-kuh has the mark of death about it — uninhabited, still, and full of signs of the reputed earthquakes... there can be no doubt that volcanic action has here been most recent” (56).

Apparently, he refers to the huge landslide that in historical times blocked the valley creating Lake Irene, originating from the steep slopes of Shuturun-kuh where the landslide scarp coincides with the extension to the south of the fault-break associated with the 1909 earthquake. Referring to the upper reached of the Darreh Luku, Sawyer says:

“One valley, especially well watered, with plenty of flat spaces for cultivation, near which are the remains of Ancient Armenian stone villages, is now deserted on account of the frequent earthquakes that heppen, the effects of which are seen by the masses of huge rocks sprinkling the lower spurs of the Shuturun-Kuh (*). Near its centre is a small lake, touching the northwest end of which is a small volcano to all appearances of but recent extinction (sic)” (56).

It is very probable that the frequent earthquakes to which Sawyer refers include the earthquake of July 1853 which occurred about 50 kilometres to the southeast of Lake Irene, in the Feridan and Chahar Mahal districts. From contemporary accounts, mainly Armenian from Julfa, we know that this earthquake devastated the region between Tarun, Akhoreh, Farsan and Chiga-Chor in which many Armenian settlements were ruined and later abandoned. This earthquake, which should have been as large as the Silakhor earthquake, caused some damage in Isfahan and it was strongly felt in Golpaigan. Other, smaller shocks are known to have occurred before and after 1853 in the Lendjan district causing considerable damage to Kert and Akhoreh. It is rather strange, therefore to read in Nikolski's report that

“By questioning the few survivors, Luris and Bakhtiaris (in the Silakhor Valley) who up till now had never experienced

(*) Rockfalls in this valley are also noticed by Morgan (49) who visited the region a year later.

an earthquake, and who maintained that to their knowledge there never were any earthquakes in their district, it became clear that the populace was struck by the disaster totally unprepared, while asleep" (51).

As a matter of fact, local tradition was and still is full of legends about earthquakes and about their effects on mountains, rivers and springs of water. It is very curious that those interviewed by the Russian mission in Silakhor did not remember or knew nothing about the destructive earthquake of Feridun which five years earlier seems to have been responsible for the eventful migration of refugee Posekis and Isavandis from the Tarun area, about 70 kilometres to the southeast of Dorud, into Silakhor.

In connection with the 1909 earthquake, the only evidence of large scale landslides and rockfalls comes mainly from local information (*). It is said that about three farsakhs (18 kilometres) from Arjanak in the Mavar-Zarrin, a large portion of the mountain flanks, measuring at least a farsakh in length, fell into the valley "with such a tremendous impact that it caused the earthquake which ruined Silakhor". Our informant adds that rockfalls continued for some time keeping those who survived the earthquake trapped in the valleys: "this calamity stopped on the day of the death of Hussain (**), after which new springs of water appeared but which unfortunately dried up a few years later".

Also in the Ab-i-Diz gorge, between Cham-Chit and 'Abbid, local information suggests that the flow of the river was arrested by landslides. Elsewhere, particularly on the southwest and south slopes of Kuh-i-Farangi, along the Ab-i-Kut river, landslides and ground deformation caused great damage causing some of the fortified settlements to be abandoned.

The shock was strongly felt in Hamadan, Arak (Sultanabad), Golpaigan, Dizful and Zohab. It was felt slightly in Baghdad, Kifri and Sulaymanieh, Kharput, and Tabriz (?). It was not felt in Tehran, Ahwaz, Bushire and Shiraz.

Long-distance effects were reported from Burujird where 18 inches of water was thrown out of the tank in the Governor's garden by the

(*) F. O. 371 713/nos. 9806 and 13665 and F. O. 249 968

(**) 10th Muharram 1327 a.H = 1st February 1909.

rocking of the ground (*). Water was thrown out of the large natural pond near Arjanak, not only by the main shock but also by an after-shock early in 1909. In Burujird, as well as in Khorramabad, although the shock caused no damage, it was strong enough to cause pots and pans to fall off shelves and water to spill out of small containers.

Up to the end of March, at least four shocks were felt daily in the Silakhor Valley. In April, intermittent strong shocks were reported from the Japelak-Borborud area as well as from the region of Razan, west of Silakhor, the latter shocks being felt in Khorramabad. Some of the aftershocks must have been very strong; in the villages of Gholah and Suran they caused the total collapse of houses killing a number of marauding Sagvandis (?) who had established themselves in the ruins of the villages. Aftershocks also drove a number of refugees from Silakhor off villages in the Japelak district where they had sought shelter after the earthquake. During the three months following the main shock 10 strong ones are reported to have taken place of which 3 had been very violent, the rest of a lesser degree⁽⁵⁴⁾. The aftershock sequence seems to have ended late in June 1909 (**).

Later in the year, on the 21st September, Sir G. Barclay requested his Consuls in Persia to supply him, for the information of the Seismological Committee of the British Association for the Advancement of Science, with reports of any earthquake which may take place in their districts (***) .

CONCLUSIONS

The Silakhor earthquake of 1909 and its aftershocks caused damage within an area of at least 40,000 square kilometres, which extended from Valian in the northwest to Homa and Arjanak in the southeast, Figure 5. Within this area 8,000 people and thousands of animals were killed. Damage was particularly heavy not only in the densely populated valley of Silakhor but also in the sparsely settled areas of Ab-i-Kut and Razan on the northwest and of the mountainous tribal settlements of

(*) I.O./L/P & S/7/227 Political Diary Bushire no. 13/647.

(**) The Kermanshah Consular Diary for w/e 6 July 1909 states that: "It is reported that there is a volcano in active eruption in the same place where the earthquake took place in February last near Burujird".

(***) F.O. 248/968

Ab-i-Holvar and Darreh Luku in the southeast, where many tribesmen perished.

The earthquake was associated with faulting, which extended almost continuously for a distance of 45 kilometres from Kulanganeh on the northwest to southeast of Saravand. Ground deformations and landslides suggest that actual faulting extended further southeast of Saravand into the Darreh Luku valley for another 20 to 30 kilometres. Ground deformations, of unknown origin also occurred between the villages of Zhan and Suran on the northeast side of the Silakhor valley as well as in the region of Kuh-i-Farangi in the Razan area. Much of the 1909 faulting, although today in places heavily eroded, is still visible on the ground, and can be seen very clearly on aerial photographs along a length of at least 40 kilometres. (Plate 5 shows an aerial view of the fault-break near Dorud).

The Silakhor earthquake was followed by a very long sequence of aftershocks which lasted for five months. There is some evidence that most of the stronger aftershocks occurred on the northwest and southeast ends of the meizoseismal region, and that they added to the damage done by the main shock which ultimately covered an area of 40,000 square kilometres.

This paper shows that given certain conditions it is perfectly feasible to study an earthquake that occurred three-quarters of a century ago in a remote part of the Near East. Also, it shows that there are many large earthquakes which, because of lack of interdisciplinary efforts to study such events, they have remained hitherto little known or totally unknown. The case of the Silakhor earthquake makes one to suspect that many other, more recent and older earthquakes might still be available for study from published and unpublished documents and from field work.

Notes on Table 1

Table I lists villages, nomad settlements and camps as well as fortified encampments which were affected by the 1909 earthquake. For each village or nomad camp Table I gives the name, with alternatives, and the district in which the village is located, the major tribal group and the name of the land-owner. The districts affected are:

Bardeh Sareh	= BAR	Kaghch	= KAG
Borborud	= BOR	Qaed Rahmat	= QAD
Chalan Culan	= CHIL	Razan	= RAZ
Dalvand	= DAL	Silakhor	= SIL
Heshmetabad	= HES	Zallaqi	= ZAL
Japelaq	= JAP	Zaz va Mahru	= ZAZ
		Zhan	= ZHN

The following tribes and sub-tribes were in the epicentral area:

Abdulvands	= abd	Papis	= pap
Garavands	= gar	Posakis	= pos
Hajjivands	= hjj	Pulandvands	= pul
Isavands	= isv	Shillarvands	= shl
Mogoi	= mog		

Land-owners whose property was lost in the earthquake were:

- | | |
|--------------------------------|--|
| 1. 'Abd 'Ali Mirza | 13. Mirza Kulli Khan |
| 2. 'Ala al Mamalik | 14. Mirza Muhammad 'Ali Khan
Mustaufi |
| 3. 'Ali Khan | 15. Muhammad Khazin Khan |
| 4. Asad Khan | 16. Qismat al Dauleh |
| 5. Hajji Aqa | 17. Sabaq as-Sultaneh |
| 6. Hajji Aqa Fakhr al Din | 18. Sardar Mukarram |
| 7. Hajji Aqa Ghulam-i-Husain | 19. Sartip Akbar Khan |
| 8. Hajji Mansur al Mamalik | 20. Sipeh Kikdar |
| 9. Hajji Mizza Muhammad Husain | 21. Zill-i Sultan |
| 10. Hajji Samsam al Mamalik | 22. Local Hojjas |
| 11. Imam Juma | 23. Local Khans |
| 12. Inayat al Mulik | 24. Tribal property |

Damage is abbreviated as follows:

- DDD = total destruction with more than 50% of the inhabitants killed,
 DD = heavy damage with less than 50% of the inhabitants killed,
 D = heavy damage without casualties,
 d = small damage.

T A B L E 1

'Abbid	DD	('Abbad, KAG-gar-23) Tribal settlements heavily damaged and 25 people were killed; rockfalls
Abikut	DD	(RAZ-gar-24) Fortified settlements demolished; many animals killed; landslides; springs of water dried up.
Afraneh	d	(Afranvadeh, SIL-23) All houses cracked, a few walls fell.
Ahmatabad	d	(CHL-23) Minor damage; change in yield of spring water.
Ahmatabad	D	(BOR-pap-23) A few houses collapsed killing 2 people.
Akbarabad	DD	(HES-22) Almost all houses were destroyed and 6 people were killed; ground deformations, slumping and lurching.
'Aliabad	d	(BAR-23) Minor damage.
Amirabad	DDD	(Mirabad, KAG-8) Totally destroyed: 76 people were killed in the citadel and 44 in the village; 510 animals killed; ground cracks and mud volcanoes.
Angoshteh	DDD	A watch-tower near Angoshteh was demolished.
Anuj	d	(BOR-shl-24) The fort was badly damaged; no casualties.
Arjanak	d	(BOR-is-4) All houses and citadel cracked; rockfalls in the vicinity; water sloshed out of pond at Ab-i-jan.
Ashrafabad	D	(Agirefabad, BOR-pos-23) The fort was destroyed and many houses were ruined, a few animals killed.
Azna	D	(KAG-23) a number of houses destroyed; no casualties.
Badakhuni	DDD	(KAG-3) Totally destroyed and abandoned for some years; all animals perished and 20 people were killed; ground deformations, mud volcanoes.
Bahreïn	DDD	(Dorud, KAG-10) Totally destroyed including the fort, two mosques, public bath, Imamzadeh and surrounding houses; in the fort 24 people were killed and another 130 in the village; landslides and rockfalls from the hill on which the fort stood.
Bahramabad	DD	(KAG-21) Almost totally destroyed: 13 people killed; village abandoned for sometime and

		rebuilt as Olia and Sofla; new spring of water appeared after earthquake.
Balabashi	d	(SIL-22) Allegedly damaged.
Baraftab	D	(ZAZ-hjj-24) Many animals in nomad camps perished from rockfalls; a ruined fort collapsed.
Barzan	DDD	(HES-1) Totally destroyed; not a single person survived.
Baytun	d	(SIL-23) A few animals killed; minor damage.
Borjla	d	(BOR-pap-23) Khan's residence collapsed; no casualties.
Budineh	DDD	(HES-23) Totally destroyed; no survivors.
Bunkabad	DDD	(HES-23) Totally destroyed; 180 people killed, few survivors.
Chahah Cheshmeh	d	(BOR-hjj-24) Springs of water dried up; landslides; no damage to nomad camps on the area.
Chalan Chulan	d	(CHL-23) A few houses were damaged.
Chamanar	DDD	(Chammar, HES-16) Totally destroyed; very few survivors; landslides and rockfalls killed a new nomads in camps south of Chamanar in the Marburreh valley.
Cheshmeh Saranjeh	DDD	(Ab-i-Cheshmeh, KAG-10) All adobe houses of nomad settlement destroyed, killing 13 people; landslides.
Cheshmeh	DD	(Ab-i-Cheshieh: DAL-10) All forts in the Ab-i-Kut valley collapsed; changes in spring water.
Choqa Bahram	DDD	(KAG-2) Totally destroyed; few survivors.
Choqa Abdar	DDD	(KAG-3) Totally destroyed; 150 people and all animals killed ground deformations and slumping,
Choqa Dun	DD	(HES-23) Heavily damaged, many people killed.
Churuq	d	(Quruq, SIL-23) A few houses collapsed, no casualties.
Darab Astaneh	DDD	(HES-hjj-23) Razed to the ground; out of 500 people 218 were killed together with all animals; rockfalls, ground deformations: springs dried up temporarily; new springs appeared.
Darband	D	(BOR-pap-11) A few houses collapsed; no casualties.
Darmiyan	DD	(HES-6) All houses destroyed or damaged beyond repair; 10 people killed, village temporarily abandoned.
Darreh Asbar	DDD	(HES-23) Totally destroyed; few survivors; landslides and ground deformations.

Darreh Chenar	D	(ZAZ-hjj-24) Nomad camps overwhelmed by rockfalls; a few ruined houses collapsed.
Darreh Takht	D	(BOR-pap-24) A number of houses were ruined; no casualties.
Daryab	DD	(Darab, KAG-19) All houses ruined; a few collapsed killing 14 people.
Daulatabad	d	(Bor-23) A few people were injured; minor damage.
Deh Agineh	DDD	(Dehayneh ve Yusufabad, KAG-8) Razed to the ground; 70 people and all the animals of the village perished; abandoned temporarily; ground deformations, change in spring water.
Dehnau	DDD	(ZHN-5) Totally destroyed; 130 people killed; ground deformations, mud volcanoes; abandoned temporarily.
Deh Qadi	D	(ZAZ-hjj-24) At this locality many nomads were overwhelmed by rockfalls and avalanches (?)
Dinarabad	d	(SIL-23) A few houses were ruined; no casualties.
Dukhamarin	d	(KAG-23) Minor damage; changes in spring water.
Emerat	D	(ZAZ-hjj-24) In this region a fortified settlement was ruined and many families of nomads were killed together with their flocks (by avalanches?).
Fimanabad	DDD	(KAG-shl-8) Totally destroyed and abandoned; 54 people killed with all animals, an old fort was ruined; ground deformations.
Gavkusheh	DD	(Gavkoshteh, Gavkujeh, HES-16) All houses destroyed killing 25 people.
Gesheshabad	DDD	(RAZ-gar-9) Totally destroyed and abandoned; two towers near by, in the Ab-i-Kut valley were destroyed; springs of water turned salty.
Ghaziabad	d	(?-shl-24) Water burst out of the ground flooding the village.
Gholah	DDD	(Golgurchah, ZHN-24) Razed to the ground (by an aftershock?).
Golbahar	d	(BOR-24) Ruined, without casualties; abandoned and rebuilt.
Gorji	D	(Gershezabad, Ghurdji, JAP-pap-24) An old fort and 20 houses collapsed without casualties.
Gushch	d	(KAG-23) Suffered some damage (by an aftershock?)

Gushchpul	DD	(KAG-19) Partly destroyed; 23 people and all animals killed; ground deformations.
Hamliyan	d	(HES-22) A few houses collapsed without casualties.
Hasak	d	(ZAL-24) Springs of water dried up; minor damage to houses.
Havch	d	(BOR-mog-24) An old fort collapsed; minor damage to houses; water gashed out of the ground.
Hayderabad	d	(SIL-gar-23) A few houses were damaged.
Hesjmetabad	D	(HES-23) Houses collapsed killing animals.
Homa	d	(BOR-mog-13) Springs of water in the district dried up; part of the wall collapsed: no casualties.
Husainabad	DD	(KAG-10) Most houses collapsed killing 24 people; ground deformations.
Juy Asiab	D	(BOR-pos-22) The fort and citadel collapsed.
Kahriz	d	(SIL-23) All houses damaged.
Kakah	D	(Kushgak, Kaskah, BOR-23) 10 houses were destroyed.
Kalehjangi	d	(Qal'eh Jahangir, ZHN-23) All houses damaged.
Kaleh Kaleh	DD	(Kuleh-Kuleh, Kalkaleh, JAP-16) Many houses collapsed killing 25 people.
Kamendan	D	(Qal'eg Kamendan, BOR-bos-22) All houses damaged; the citadel collapsed. Many nomads were killed by rockfalls near this place. In the mountains to the southwest of the fort many families of the Abdulvand tribe perished.
Kenikuh	D	(BOR-abd-24) A new spring of water appeared after the earthquake; damage to local houses was heavy.
Khanabad	d	(ZAZ-shl-24) A few adobe houses were damaged.
Kert	d	(JAP-pap-23) Partly abandoned at the time of the earthquake; old ruins collapsed together with an old Armenian building. Near Mas'udabad landslides blocked the pass.
Khosraumirch	D	(BOR-shl-24) An old castle collapsed killing a few people.
Khosraabad	DDD	(KAG-5) Destroyed; 6 people killed, abandoned for a few years.
Kulanganeh	D	(KAG-22) A few houses collapsed without loss of life.
Kuliabad	DDD	(Kole Abad, Golabad, RAZ-gar-6) Totally destroyed and subsequently abandoned; 30 people

		killed; many nomads in the Rangrazen area perished and a number of forts were ruined. Springs of water dried up and pastures dried up.
Kuyabad	D	(KAG-23) All houses damaged beyond repair; ground fissures and mud volcanoes; no casualties, village abandoned for two years.
Laban	DDD	(KAG-14) Twin village of Lavan Olia and Sofla destroyed completely including the citadel; 25 people were killed together with all cattle; ground deformations and mud volcanoes; underground water flooded the space between the two villages.
Mahmudabad	D	(JAP-22) Many houses were ruined; no casualties.
Makehdin	d	(ZAL-mog-13) A few houses and the Imamzadeh were ruined; no casualties.
Malekabad	D	(BOR-shl-24) All houses were damaged; no casualties.
Mirzan	DD	(KAG-10) Qal'eh Mirzai collapsed together with many houses killing 20 people; near-by Baba Mirzai was razed to the ground where 30 people were killed; abandoned for some time and resettled later by families of Baba Khuni. Ground cracks and mud volcanoes.
Mir Ahmadi	DD	(?-19) 11 people killed; no trace of this locality.
Miyan Ruyan	DDD	(Miyan Rudan, Miurudon, JAP 21) Completely destroyed; not a single survivor left; landslides.
Murabak	d	(KAG-23) All houses damaged.
Nasiraldin Pain	DDD	(ZHN-2) Razed to the ground; 200 people killed together with all the cattle.
Nasiraldin Bala	DDD	(ZHN-2) Totally destroyed; all 154 inhabitants and their animals killed; ground deformations.
Nushk	d	(KAG-23) A few houses collapsed; no casualties.
Pirabad Sofla	DDD	(ZHN-7) Totally destroyed and 60 people were killed; all cattle perished; village abandoned for two years.
Pirabad Olia	DD	(ZHN-7) Out of 500 people, 4 were killed; all houses destroyed or damaged beyond repair; many animals killed.
Pishkashan	DD	(Pushkestan, KAG-23) Heavy damage; 30 houses collapsed killing 14 people.
Qal'eh Qaed	DDD	(QAD-23) The fort was destroyed and 58 nomads were killed in the Kul Darreh region near Qal'eh Qaed.

Qal'eh Rustam	DDD	(JAP-abd-16) Completely destroyed; few people escaped unhurt; landslides; new springs of water.
Qal'eh Qasim	DDD	(QAD-12) Razed to the ground together with near-by forts on the Ab-i-Kut; few nomads escaped unhurt.
Rakan	DDD	(Raikan Olia & Sofla; KAG-pul-23) Totally destroyed; large scale landslides and rockfalls.
Rangrazan	DDD	(DAL-gar-18) Hundreds of families of Varavandis perished in this region; at Rangrazan 70 people were killed and the banks of Ab-i-Harud slumped;
Razan	DD	(RAZ-gar-24) All houses collapsed; no casualties.
Sanbadan	DD	(Sureh Vardi, Sunabeddin, HES-10) All houses collapsed killing 6 people; ground deformations.
Sanbal	DDD	(?-10) Razed to the ground; 50 people killed; no survivors; location of site not known.
Sandargan	DDD	(KAG-12) Almost all houses collapsed; 20 people killed; village rebuilt by survivors of Baba Khuni.
Sangar	DDD	(KAG-8) Totally destroyed; out of 400 inhabitants only 3 survived; all cattle killed; in citadel which collapsed, 42 people were killed; Sangiyareh district abandoned.
Saravand	DDD	(HES-abd-23) Completely destroyed and 130 people killed; rockfalls killed many nomads in the vicinity.
Shahpir Vali	DDD	(?-24) Totally destroyed; abandoned?
Shalmakan	D	(ZAZ-hjj-24) many houses collapsed; no casualties.
Shakarabad	DDD	(KAG-24) Completely destroyed; abandoned for two years.
Shengan	D	(BOR-pos-23) In the village and in the vicinity many nomads perished.
Shur	d	(ZHN-24) Ground deformations; a number of houses were damaged.
Sireh	DDD	(Al-Sireh, Lasureh Olia & Sofla, HES-23) Completely destroyed; 50% of the population and 100 of the cattle perished landslides and ground deformations; a new spring of water appeared for a short time after the earthquake.
Siyahkaleh	DDD	(KAG-12) Totally destroyed; 194 people and all cattle perished; ground deformations.
Siyaval	DDD	(KAG-23) Totally destroyed; 80 people killed.

Sivaleh	D	(BOR-isa-24) A considerable number of nomads perished in the region.
Sultanabad	d	(BOR-24) A few houses were ruined.
Sultan Mahmud	DD	(?-24) Heavily damaged; 15 people killed.
Suran	DDD	(Sirun, Suzan, HES-17) Completely destroyed; many lives lost; ground deformations.
Tanurdar	DD	(Tanur-darreh, Tarudar, KAG-5) Almost all houses collapsed killing 15 people, a spring of water dried up permanently.
Taqiabad	DDD	(KAG-23) Completely destroyed; 200 people lost their lives; ground cracks and flooding of the area.
Tiyan	DDD	(Tivan, JAP-20) Totally destroyed with great loss of life; landslides.
Turshab	DDD	(HES-15) Completely destroyed; half its population killed; all animals perished.
Valian	d	(SIL-23) A number of houses damaged; an imamzadeh and a caravansarai were ruined; ganat water changed.
Yazdgirt	d	(KAG-23) All houses damaged.
Yusufabad	DDD	(KAG-8) Totally destroyed; 44 people and all cattle killed; slumping of the ground; temporarily abandoned.
Zan	D	(Zunah, San, Zhan, ZHN-23) All houses damaged, a few collapsed, ground deformations.
Zargaran	D	(Zargina, KEG-8) 10 out of 200 houses demolished killing much cattle; no casualties.
Zarnan	D	(Zarnu, JAP-23) Many houses ruined; old Armenian tower destroyed; ground deformations

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